THE MANAGEMENT OF RANGE LANDS

FROM

THE WESTERN RANGE—A GREAT BUT NEGLECTED NATURAL RESOURCE

FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

SENATE DOCUMENT 199—SEPARATE NO. 15

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1936

THE MANAGEMENT OF RANGE LANDS

By L. F. Watts, Director, Northern Rocky Mountain Forest and Range Experiment Station, George Stewart, Senior Forest Ecologist, and Charles Connaughton, Silviculturist, Intermountain Forest and Range Experiment Station, L. J. Palmer, Principal Forest Ecologist, Rocky Mountain Forest and Range Experiment Station, and M. W. Talbot, Senior Forest Ecologist, California Forest and Range Experiment Station

The essential features of the program for the management of the western range lands are interwoven throughout the whole agricultural fabric of which it is an integral part. Dependent individuals, rural communities, and to a lesser extent the urban centers, have not enjoyed the social and economic security which sound development should bring. The rule-of-thumb methods, discussed previously, which have been used in handling range lands have resulted in excessive stocking and serious range depletion. If this condition is to be corrected, technically sound range management practices must be substituted. This is the premise upon which the proposed program is based.

Clearly, the forage crop should be so used as to maintain the highest state of productiveness and at the same time afford the greatest total contribution to the livestock industry and other legitimate services of the range. Numbers of livestock; availability of range for each season of use; the production of supplemental feeds such as hay, grain, agricultural byproducts, and irrigated pastures; and the requirements for wildlife, recreation and watershed services, and timber production on forest ranges, must be kept in balance if maximum production without misuse of the range is to be had.

The livestock contribution must, as nearly as possible, be predicated on sustained production. This means stocking of the ranges only to that point where—the possible use of supplemental feeds considered—excessive forced shipments will be unnecessary even during drought years. The apparent surplus of forage left on the range during good years will constitute a worth-while investment in soil and plant building, watershed health, and in feed reserves for the dry years.

The halting of unchecked damage and the rehabilitation of depleted ranges is the first step in the program. Overgrazed and run-down ranges on which the volume or quality of forage now produced has been seriously reduced through improper use must be brought into satisfactory condition. Generally this will simply mean lighter stocking and better management, but for some conditions a complete rest of the range for a few years will be necessary. In the worst instances of depletion by grazing, and on a large part of the land which has been plowed and abandoned for crop use, artificial reseeding will be required if something approaching maximum productivity is to be realized within a reasonable time.

Under such a program the best contribution that the range, all things considered, will make to social and economic well-being will

be through the maximum application of the multiple use principle. Pasture for domestic livestock, watershed protection, feed and cover for wildlife, recreational opportunities, and timber production where practicable are all legitimate services which range lands can supply. Except for limited areas, range land can contribute to each of these services without excluding the others. Conflicts between the desires of special groups often represented by organized vocal minorities will have to be met. The solution in each instance requires the type of coordination which results permanently in the greatest service to the most people.

More recognition should be given to the extent to which depleted ranges counterbalance improvement made by livestock breeding. As shown in discussing the functions of an integrated agriculture for the West, the increased values which good breeding should insure to the stockman are too often lost because of the low plane of nutrition furnished by overgrazed or depleted ranges. Light-weight feeder steers and half-fat lambs, instead of grass-fat steers and "top" lambs, are dumped on glutted markets. Calf and lamb crops are reduced materially. But the most serious repercussion of overstocked and depleted ranges on animal husbandy comes during drought years, when breeding herds built up at great expense over a period of years too often must be sacrificed. Thus the profits expected from improved animal-husbandry practices are reduced if not entirely lost.

Lack of certainty in predicting future requirements for agricultural products is a national problem. The future balance between export demands and import needs, and even the possible volume of domestic consumption are baffling questions to which the best thought of the Nation is being directed. The estimate that more than 25 million acres of now submarginal cropland, not yet abandoned, must be diverted to other use is based in part on the threat of periodic overproduction. That most of this land must revert to pasturage is obvious. Thus new concepts in range stocking, in providing for wildlife, in improving watershed conditions, and in recognition of recreational needs are being worked out.

Conversely the range may serve as the reservoir of land from which to draw additional acreage for crop agriculture if needed. Reclamation through irrigation as a part of the resettlement program, for example, seems logical and will remove some of the more fertile level land from range use. Emergencies, such as those which arose during the World War may arise again and require temporary major increases in crop acreage and in livestock production. Such demands will be met more easily if the natural range lands are rehabilitated to maximum productivity and the soil on areas now submarginal for crop use is improved and protected from erosion by providing a satisfactory plant cover. Thus the range may well be one buffer against contingencies which arise from changing land-use requirements.

Although the program best suited to meet the needs of the West should be built around the multiple-use principle, for simplicity of presentation each of the five major functions of livestock production, watershed protection, wildlife, recreation, and timber production will be discussed separately.

A Program for Domestic Livestock Production

Three systems of grazing have been recognized as desirable to restore and maintain the plant cover. As described below, the conditions which must be met will decide which system is best for a given area.

SYSTEMS OF GRAZING

Deferred and rotation grazing (*114*)[47] reduced to its simplest form means dividing the range into from three to five units and deferring grazing on one unit each year until after the seed crop has matured. By so treating a new unit each year the entire area will be rested and grazed in rotation.

The system, developed on mountain ranges, is primarily applicable to stands of perennial grasses that are chiefly dependent upon seed for their perpetuation. Other systems of conservative management may be better adapted to certain types of short-lived annual forage plants which dry quickly and are less palatable after maturity, or to certain perennials that reproduce by runners or "stooling" instead of seed.

Experience has shown that most forage plants can, after seed maturity, withstand the removal of as much foliage as is ever desirable from the standpoint of good range management. As a guide to intensity of this deferred use, 20 to 30 percent of the palatable growth of the important forage plants should be left when the stock are finally removed for the year.

The deferred and rotation system is especially adapted to use on sheep range. The close control under which the band is held makes the system usable without the cost of fencing. With cattle or horses its use becomes complicated, in many cases requiring, in addition to salting and herding control, the construction of drift fences or pastures if the stock are to be held off from deferred areas. With ample range for each season, however, the objective should be to so handle most range areas to which the system is adapted.

In application, the number of divisions of the range is based on the period of grazing left after seed maturity. For example, if one-fifth of the season remains after seed maturity, the range may be divided into five parts and each year one of the five divisions is in turn left ungrazed until toward the end of the season. After the seed has ripened, the stock are moved to the area and in grazing over it help to scatter the seeds and cover them with soil.

In order to protect the new seedlings which germinate the following spring, the area deferred 1 year should be grazed next to the last the following year. The objective, of course, is to secure an ample seed crop, help seedlings to become established, and provide protection until they become a part of the native plant cover.

Continual moderate grazing is more suitable than deferred and rotation on (1) ranges used yearlong, such as those of the Southwest; (2) on many cattle ranges where it is not now feasible to construct the fences and structures required to control the movement of the stock; (3) for those important forage species that are

[47] Because of space limitations the treatment of technical features of range management must here be kept brief and simple. The references cited throughout this section cover the topics in detail and cite additional literature on the specific subjects.

not dependent on seed for reproduction; and (4) locally in Arizona, the Northern Great Plains, and California where certain areas are used during the winter and others during the summer. Where this system is used the number of stock grazed must be small enough to permit about one-fourth of the seed from the better forage plants to ripen. It is very desirable to so handle the stock that each year a portion of the range is used very lightly, since rest periods for the range and a chance to build up plant vitality are essential. This system requires frequent and careful inspection to make sure that the better forage species are not progressively being eliminated.

Alternate grazing is limited to ranges where it is possible to use a tract for a few weeks, after which all of the stock are removed to another area and kept there until the forage on the one first grazed has made enough growth to withstand another period of use. This system is highly effective on cultivated pastures under irrigation or in humid regions where heavy grazing for short periods helps to keep the coarse plants in check. On arid ranges, however, the heavy use for even a short period is likely to damage the soil, encourage erosion, and destroy part of the plants by trampling. Obviously this system can be applied much less generally than deferred and rotation grazing or continual moderate use.

RANGE REHABILITATION

Most of the 721 million acres of usable range land can be restored to full productivity during use if the numbers of livestock grazed and the systems of management provide fully for natural revegetation and protection of the plants after establishment. On possibly 340 million acres of these lands, though there has been loss of fertility, there is enough topsoil rich in organic matter and with sufficient water-holding power to insure forage recovery if the intensity of grazing and period of use are corrected. All that the plants require under these conditions is a chance to grow green leaves, to retain them long enough to produce sufficient plant foods, and to bring about food storage in the plant roots and stems. Plants so protected are vigorous and either by seeding or otherwise will reproduce satisfactorily. An opportunity for existing plants to retain their vitality and reproduce is absolutely necessary if ranges are to be restored and maintained.

Unfortunately, well over 100 million acres of range lands has been so badly abused by grazing that most or all of the fertile topsoil is gone, on which conditions of both nutrition and moisture are unfavorable for plant growth. On such soils, even under moderate grazing, natural revegetation is slow. No great increase in vigor of old plants can be expected until the soil is built up. Several plant generations of weeds, annual grasses, and other plants capable of growing on poor soils of low water-holding capacity will be required. Complete closure to grazing, and other special treatment, including artificial reseeding, may be necessary.

Artificial revegetation is necessary on nearly 38 million acres of range land from which the desirable forage species have been largely removed. Two types of land are involved: (1) those areas from which all of the desirable forage has been eliminated by plowing for crop agriculture, and (2) those on which continued grazing abuse

has depleted the vegetative cover, and in some instances the soil, to a point where natural revegetation satisfactory for grazing or watershed protection will be entirely too slow of accomplishment. Studies in Montana, Colorado, and Utah, discussed elsewhere, show that for the first type of land it will take 20 to 50 years to restore the native cover.

On good soils, either abandoned plowed or denuded range land, perennial grasses and the most valuable herbs and shrubs may be seeded at once. The abandoned dry farms that make up the larger part of this class of land originally produced fine crops of native grasses. Normally, the soil is still good enough to justify prompt reseeding with the best plants available. No attempt is here made to name the species best suited to given regions as conditions vary so greatly that final choice must be based on the characteristics of the site and locality to be planted. The State agricultural colleges and the Forest Service can furnish advice based on experience. On these better areas reseeding is a relatively simple problem. However, the likelihood of drought makes it unsafe to predict success more than half of the time, and therefore, in estimating costs for large areas it is safe to assume that two seedings will on the average be needed.

On eroded soils which lack the proper plant foods, the problem is far from simple, as the sowing of perennial grasses and other of the most valuable forages offers little hope of success. Only those plant species that can withstand raw soils and irregular moisture supply can succeed. In order to restore this class of range a detailed study of soil condition and also of the plants that will survive must be made. Native weeds and legumes and imported species must be tried and provision must be made to collect or produce seed in ample quantities from those that are successful. Plant breeding to develop desirable strains suited to badly depleted soils is urgently needed. For certain species the planting of pieces of sod or rootstocks is more logical than propagation by seed. Also in many instances cheapest and most satisfactory results will be had by revegetating numerous small spots or key areas from which a cover will spread to or fill in the space between.

On abandoned crop land and other level denuded areas the common grain drill with a part of the holes plugged is very effective. Usually, even in the case of heavy stands of Russian thistle or other weeds, it is best to drill on land not prepared by plowing or harrowing. If the weeds interfere seriously with the operation of the drill they may be burned broadcast or in windrows. Seeding on unprepared ground not only reduces the cost but in many instances will increase the percentage survival.

Great areas of rough, steep, and brush-covered ranges cannot be drilled. Under such conditions the seed must be scattered by hand and trampled in with livestock or by other inexpensive methods. A few areas not suitable for drilling, but with good soils and in key locations, ought to be seeded on furrow edges plowed at intervals and covered with a brush drag. The labor costs by this method are high, but its use on key areas having deep productive soils makes success likely.

Whatever the method of reseeding and whatever the plant species reseeded, complete protection from grazing for one or two seasons is required in order to permit the seedlings to establish themselves.

Very often it may be desirable to supplement by artificial reseeding the natural reseeding provided for on that part of the range to be improved by deferred and rotation grazing, or by continual moderate grazing. In such case the expense and trouble of reseeding require that proper intensity of stocking and proper grazing management be provided in order to prevent failure.

Cost figures for the various methods of artificial reseeding for range use are not too reliable, but using the methods described they should be low. The most serious problem is that of securing a sufficient supply of suitable seed. Assuming that an ample seed source will be developed as needed, and that a market price of around 15 cents per pound may be expected, the cost, using a grain drill and 4 to 5 pounds of seed per acre and figuring on failure half the time, should not exceed $2.50 to $3 per acre. With hand seeding and trampling in by livestock, the cost for two seedings should not exceed $1.50 to $2.50 per acre. Final decision as to the necessity and feasibility for planting any area must, of course, be based on careful consideration of conditions on the ground. Detailed surveys required to select areas are in most cases lacking; therefore the data given in table 80, which gives an estimate of acres and costs, by ownerships, are only indicative of the size of the job ahead.

TABLE 80.—*The extent of the indicated artificial range-revegetation program and costs, by ownerships*

Ownership classes	Area (acres)	Cost per acre	Total cost
National forest	780, 000	$3. 50	$2, 730, 000
Indian lands	1, 630, 000	2. 85	4, 645, 000
Public domain, grazing districts, etc	18, 000, 000	2. 55	45, 900, 000
State and county	2, 490, 000	3. 05	7, 595, 000
Private	15, 010, 000	3. 20	48, 032, 000
Total	37, 910, 000	2. 87	108, 902, 000

PESTS, DISEASES, AND POISONOUS-PLANT ERADICATION

Poisonous plants are a menace to the success of range revegetation or utilization. Most poisonous plants occur in great abundance only on ranges so badly depleted that the more valuable forage species are weakened or killed. In the more open spaces, on soil too poor in organic matter to support the better forage grasses, weeds come in. Some of them, like low larkspur, loco, lupine, deathcamas, sneezeweed, and horsebrush, are poisonous. They tend to increase on noneroded soils on which heavy or untimely grazing removes the valuable forages. Some species like tall larkspur, waterhemlock, and sleepy grass may grow on good ranges with good soils. The real remedy for most poisonous plants is to remove the causes, i. e., to bring about by conservative use, and reseeding when required, the revegetation of the range by the more valuable forages. On a few key areas, especially where tall larkspur or waterhemlock occurs, grubbing or treating with chemicals may be practiced at costs of about $3.50 an acre for grubbing or $6 for treating with chemicals. Even when these practices are resorted to it may be necessary to revegetate the range with good forage, lest the poisonous plants again occupy the area.

Rodents are a menace on about 285 million acres of range and must be checked by the use of poison bait, trapping, or by other accepted methods of treatment. The cost will be about 8 cents per acre. A reasonable 10-year program should doubtless plan on control measures on approximately 150 million acres, at a total cost of about $12,000,000.

Although native plants are not seriously injured by disease, it is possible that species developed for artificial reseeding may be. Close watch must be maintained to insure the use of disease-resistant species for range restoration. Some undesirable plants, such as "cheat grass", are subject to smut and may be thus held in check. However, it is much surer and much safer to accomplish the same thing by favoring desirable species through range management and reseeding. In the absence of fire or too severe cropping, the better native species will suppress such undesirables and succeed them in occupying the range.

GRAZING CAPACITY

The range should be stocked with the number of animals which the unit will support each season over a period of years without injury to the range, tree growth, or watershed, or unwarranted interference with game and recreation (*79*). Figure 85 graphically indicates present grazing capacity of western ranges. Since the various species of plants differ greatly in palatability, it is to be expected that the better kinds will be most heavily grazed. In determining grazing capacity the degree of use of the most palatable of the more abundant species must control. On ranges where the desirable plant species have been seriously reduced in number, stocking should be such as to encourage their return to importance. Thus, on properly stocked ranges the least palatable plants will barely be nibbled.

When a range is stocked more heavily than its true grazing capacity, either (1) the cover will get thinner, thereby exposing bare ground; or (2) the tough, woody, gummy, or unpalatable plants will increase in relative or absolute abundance. Rangers and stockmen should note carefully which plants are not eaten by livestock and check on their increase from year to year as an indication of overstocking. Experience has shown that somewhere near 20 to 30 percent of the palatable growth of the more important forage species should be left ungrazed each year. An adequate series of permanent plots from which detailed annual records of plant numbers and conditions can be kept is essential to really reliable and accurate determination of the proper degree of stocking. Also, on areas covered by range surveys, forage-acre figures arrived at by the method developed on national-forest ranges [48] will be found especially helpful.

Additional considerations in making grazing capacity estimates include, among others: (1) History of grazing use of areas; (2) fluctuations in forage crop from year to year, due chiefly to climate, as previously explained; (3) deductions (on depleted ranges) to provide a safety margin for their improvement; and (4) necessary allowances for unfavorable physical conditions, such as rough to-

[48] U. S. Department of Agriculture, Forest Service. Instructions for grazing surveys on national forests. 40 pp. 1935. [Mimeographed.]

pography, young timber growth, inadequate livestock watering places, or poisonous plants.

That range lands in all types and in all ownerships have been too heavily grazed has been fully discussed in a preceding chapter. As a result, drastic action will be required to restore this empire of range lands to something approaching maximum production. Table 81 shows by the major types the original and present grazing capacity of the land now in range and the percent to which each type has been depleted through improper management. In only the tall-grass type is depletion less than 25 percent and in only one other (open forest) is it much less than half. Since depletion is continuing on most of the range area, the task of restoring these ranges will require material reductions in the number of livestock now using the range. Table 82, which is based on the best information available, shows that an average reduction in animal-months' use of 38.5 percent will be required to bring the stocking down to a

TABLE 81.—*Grazing capacity of western range, by types*

Types	Virgin range, grazing capacity		Present range		
				Grazing capacity	
	Acres per animal-month	Animal-months per section	Depletion (percent)	Acres per animal-month	Animal-months per section
Tall grass	1.9	337	21	2.4	267
Short grass	2.1	305	49	4.1	156
Pacific bunchgrass	2.2	291	51	4.5	142
Semidesert grass	2.9	221	55	6.4	100
Sagebrush-grass	2.9	221	67	8.9	72
Southern desert shrub	4.4	146	62	11.5	56
Salt-desert shrub	5.2	123	71	17.8	36
Piñon-juniper	3.4	188	60	8.4	76
Woodland-chaparral	4.9	131	50	9.8	65
Open forest	4.0	160	33	5.9	109
Averages	2.7	237	52	5.7	112

TABLE 82.—*Present stocking, present grazing capacity, and potential grazing capacity (50 years hence) on the western range area* [1]

Ownership classes	Present stocking, animal-months per section	Present grazing capacity, animal-months per section	Reduction required to reach grazing capacity		Potential grazing capacity, animal-months per section	Change from present stocking		Increase over present grazing capacity	
			Animal-months per section	Percent		Animal-months per section	Percent	Animal-months per section	Percent
National forests	95	89	6	6.3	106	+11	+11.6	17	19.1
Indian lands	106	78	28	26.4	120	+14	+13.2	42	53.8
Public domain, grazing districts, etc.	94	53	41	43.6	94	------	------	41	77.4
State and county	226	113	113	50.0	193	−33	−14.6	80	70.8
Private	239	146	93	38.9	237	−2	−.8	91	62.3
Average	182	112	70	38.5	180	2	1.1	68	60.7

[1] Ultimate stocking is based on the formula $\frac{(100-D)\,P}{\%\,V}$, in which D is the percent of depletion, P the animal-months per section of present range, and V animal-months per section of virgin range. Virgin carrying capacity is modified by percents varying from 70 for public-domain lands (all Federal except national orests and Indian lands) to 88 for national forests, to account for some encroachment of timber reproduction, retarded improvement under continual grazing use, and especially limitations in recovery due to depleted soil. Credit is given for increased carrying capacity due to anticipated artificial reseeding. The results of the formula were modified slightly where justified by more accurate data.

point where the ranges can recover. It is significant that this reduction from present stocking varies from only 6.3 percent on national forests, where the ranges have been carefully handled for many years, to 50 percent on State and county lands, where, as a

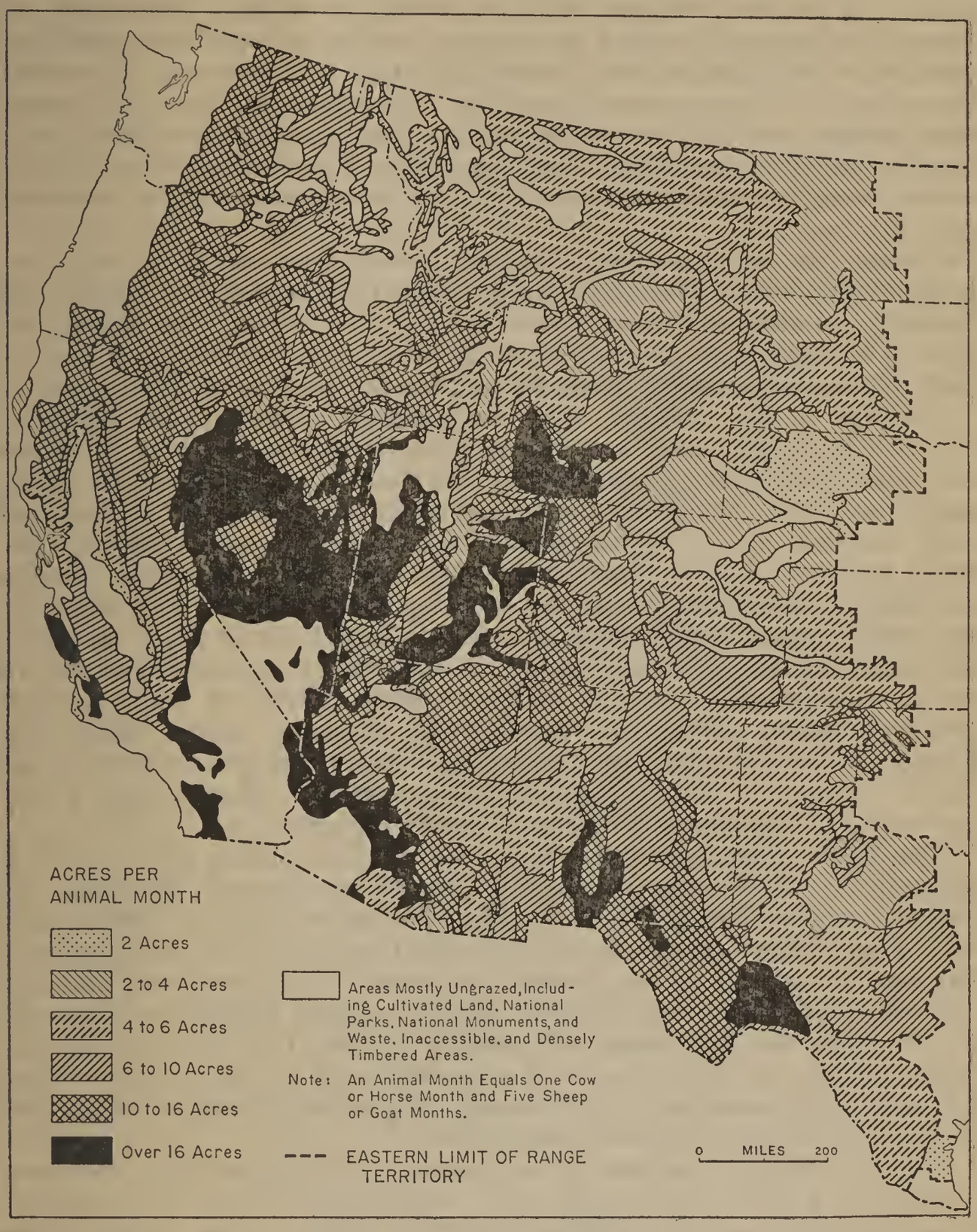

FIGURE 85.—PRESENT GRAZING CAPACITY OF WESTERN RANGE LANDS.

The tall-grass type of the prairies, which has the smallest average depletion, also has the highest grazing capacity, an average of 2.4 acres per animal per month. The short-grass and Pacific-bunchgrass ranges, although depleted one-half, also have a relatively high capacity. The salt-desert shrub type of the Intermountain Region which is depleted most severely, averages 17.8 acres per animal per month. (See figs. 25 and 30.)

result of accessibility and lack of management, use has been heaviest. Perhaps the most significant required reduction is the 43.6 percent for the grazing districts, unreserved public domain, and "other Federal" reservations, because it applies to an extremely large acreage.

PROPER SEASON OF USE

Use of the range only during the proper season is equally as important as not exceeding grazing capacity (*79*). In some regions and on some ranges, where snowfall is so light that stock can normally forage for feed in winter, moderate yearlong continual grazing with definite rest periods is the best system. However, in regions of deep snowfall, such as is common on the high mountain ranges, seasonal use is essential. At the higher elevations it may be midsummer before the vegetation has developed to a point where it can be eaten without injury to the plants or their necessary seed production.

During the early period of plant growth the soil is usually saturated with water and the plants, though palatable, are washy and lacking in balanced nourishment for stock. During this period use should be lightened or stopped to prevent great damage by trampling of the soft, muddy ground and also the pulling of many plants.

Usually in the foothill zone and valley edges of the northern two-thirds of the mountain region growth begins early as the snow retreats, but almost stops during the hot weather of midsummer. Additional growth often takes place again when the fall storms and cool weather come. In the spring such ranges are extremely valuable for use by stock moving between feed yards or winter ranges and the summer ranges in the high mountains, and vice versa in the fall. Other ranges, such as the salt-desert shrub type, on which the snowfall is light and there is ordinarily no other source of water, can be used only in winter. Thus there are four seasonal types of range, as follows: Spring-fall, summer, winter, and yearlong. On large areas in California where growth continues all winter, there is a fifth type, fall-winter-spring. The greatest shortage exists in the spring-fall class in most regions.

Yearlong ranges should always be stocked sufficiently low that damage does not occur, especially during the growth periods. As pointed out by Dr. E. C. McCarthy, formerly with the Intermountain Forest and Range Experiment Station, excessive stocking will damage the plants at any season, but most seriously during the first few days after growth starts. Winter ranges should not be used at all from the beginning of growth to late fall, thus saving the entire crop for winter use. Spring-fall and summer ranges must be carefully protected from excessive grazing during the period of growth if they are to be maintained.

The tendency to use spring-fall range, which is normally the most accessible, before the proper date must be overcome if depletion is to be halted and the ranges improved. Here is one of the places where the closest kind of coordination is required to balance the use of the resources of ranch and range. One possible relief is in the increased use of farm pastures and of supplemental feeds, both roughages and concentrates, including the expanding list of agricultural byproducts. Another possibility in certain regions is in the possible diversion of either winter or summer range to this season of use with extreme care in stocking and in management. It is certain that the problem will not be solved by abuse of the limited area of spring-fall range available. Such treatment can only aggravate the situation.

CLASS OF STOCK

Each unit of range is ordinarily best suited to use by only one class of stock (*79*). The factors which control are the character of the forage, distribution of water, and topography.

Cattle and horses do best on a range where the forage is predominately grass with a sprinkling of weeds and some browse; sheep like nearly equal parts of grass, weeds, and browse, and goats more browse. However, this balance is not especially sensitive and the presence of ample forage is the main consideration. Sheep or goats do well on straight grass ranges, and cattle on weed and browse, or sheep on browse and grass.

Frequently other factors than the suitability of the range controls the class of stock to be grazed. The local livestock industry may be built around the class of stock for which the range is not best suited. In such instances the important feature is that stocking be based on the feed that the class of stock grazed can be expected to use under good management.

Cattle must have access to water daily during hot weather but sheep can go 2 to 5 days (much longer during cool weather), depending on the succulence of the forage and the amount of dew, and can reach out farther from watering places.

Steep, high, broken ranges are more readily used by sheep, and low brushy ranges by cattle. Goats are capable of using forage on rougher, more brushy, and hotter localities than are suitable for either sheep or cattle. When one class of animals is using a range better adapted by feed, topography, elevation, or water to another class, extreme care must be taken not to overstock. Only the feed within reach and usable by the class of stock on the range should be considered in determining grazing capacity.

Some ranges, at least theoretically, will contribute most if grazed by both sheep and cattle, and some by goats as well. In practice this so-called common use has not been widely successful because of the tendency to introduce the second class of stock without reducing the numbers of the class already there to maintain sufficiently the total stocking rate at the grazing capacity of the range. Common use, thus, has usuall ymeant double use which is fatal to the range. Where forage, water, and topographic conditions are such as to permit of common use without the total stocking being above the grazing capacity for the combined classes, it may be used. Future ranges must be grazed properly in this respect, and this means scientific range management based on the forage supply.

DISTRIBUTION OF STOCK

Next to the proper rate of stocking, distribution of the stock on the range is the most important feature in range management (*79*). Any improvement in the distribution of animals is reflected in more even utilization of the forage. Overuse of small areas, especially on cattle ranges, cannot be prevented entirely, since the animals naturally congregate at watering places, at bed grounds, and along routes of travel. All of these conditions are much improved through (1) avoidance of heavy stocking, (2) providing water at short intervals.

(3) the use of sufficient, well-located drift fences, and (4) proper attention to salting and herding.

Water development (*13*, *139*) aids distribution but on many ranges involves heavy expenses for deep wells, for pumping, for the construction of reservoirs, and for the development of springs. For cattle the ideal arrangement is to so locate the watering places that the animals can graze out to the boundary of the area served in half a day—perhaps a mile on gently rolling country, and less where the topography is rough or broken. The high cost, however, usually forces a compromise between travel for the stock and cash outlay for the improvements. On gently sloping ranges, cattle can travel 2½ to 3 miles to water, but on steep slopes and rough topography 1 mile travel is probably as much as should be required. Sheep can travel roughly twice as far to water as cattle. Table 83 indicates the approximate size of the water development job on range lands in various ownerships.

Properly located drift fences (*79*) are often essential to good distribution of cattle. Not only do they help to force the use of less attractive ranges but also they are necessary in any attempt at proper seasonal use. Range cattle, particularly, have a tendency to follow the snow line back in the spring and can be successfully held back until the forage is ready for use only by a series of well-constructed and properly located fences. The best estimates obtainable indicate that the investment shown in table 84 will be required to fence properly range land in the different ownership classes.

TABLE 83.—*Range-water development program, by ownership classes*

Ownership classes	Number of projects	Costs	
		Per acre of range	Total
National forests	8,205	$0.0407	$3,362,000
Indian lands	3,000	.0310	1,500,000
Public domain—grazing districts, etc	6,050	.0202	3,022,000
State and county	3,760	.0133	868,000
Private	10,500	.0080	[1] 3,018,000
Total	31,515	.0163	11,770,000

[1] Cost estimates for the private-land program are made on the same basis as for public land. Actually a very large part of the work, if done, will be as a slack-time job. The cash outlay thus will be very much smaller than this figure.

TABLE 84.—*Range-fencing program, by ownership classes*

Ownership classes	Miles to build	Costs		
		Per mile	Per acre of range	Total
National forests	13,300	$329	$0.0530	$4,376,000
Indian lands	5,000	300	.0310	1,500,000
Public domain—grazing districts, etc	16,900	288	.0325	4,861,000
State and county	11,600	269	.0480	3,125,000
Private	19,800	315	.0166	[1] 6,246,000
Total	66,600	302	.279	20,108,000

[1] See footnote to table 83.

An ample supply of very coarse or block salt (*32*), properly distributed both as to location and as to time of use is required for equal utilization on cattle ranges. Salt grounds, particularly on poorly watered ranges, should be so placed in strategic locations away from water as to induce the use of the maximum areas of the range. The stock naturally tend to work from water to salt and vice versa, grazing en route. Obviously, a carefully planned distribution of salt grounds which considers not only the area of range to be used but also the proper time of use is a major feature in distribution. Salting is an integral part of the current operating expense and therefore no estimate of costs is included.

Herding of sheep is an old practice but needs to be done intelligently to bring about proper use of the range. "Open" rather than "close" herding, minimum use of dogs, and one night use of bed grounds are all practices which ought to be standard. Such handling not only prevents localized overgrazing and excessive trampling but also produces fatter sheep on the same amount of forage. Education, regulation, and inspection are the only costs of this step.

Herding naturally is less effective with cattle than with sheep. Cattle do not normally graze in bands and there are fewer stock to a given unit of area. Owners of large numbers of stock and associations using a range unit cooperatively should provide riders who can rather effectively direct the stock to the range which would otherwise be underused. Usually salting is a part of the function of the herder or rider. Here again the cost is an integral part of the current operation.

NEED FOR MANAGEMENT PLANS

The full use of range lands without damage by domestic livestock is dependent on continuity in applying a fundamentally sound plan. A plan followed one year and abandoned the next serves no purpose. Without this, use becomes haphazard and the evils described earlier as accompanying rule-of-thumb management are bound to result.

To be of value the plan must be simple and workable and preferably should be recorded on suitable maps. It should take into account such essential features as (1) the grazing system, (2) grazing capacity, (3) season of use, (4) distribution of stock, (5) the need for special rehabilitation measures, and (6) any special provisions needed for watershed protection, wildlife, or recreational use. For areas of any size the plan should be a written record and should be revised each year if necessary to meet changing conditions.

Unfortunately, the preparation of a thoroughly sound plan is not a simple matter. Knowledge is needed of the requirements and habits of livestock as well as of the requirements and habits of various plants. For this reason, and because professional services in this field are not otherwise available, this is a most promising field for public aid. Through extension services and with the active cooperation of the owner, plans based on available research and any necessary surveys and study of the property should be offered to private owners. The more progressive stockmen would welcome assistance in this field.

The estimates of acres and costs shown in table 85 are based on the assumption that thoroughly sound plans should be prepared for

all range land regardless of ownership. The necessary range surveys are included in the estimates because the survey and plan are almost inseparable. Costs per acre vary from 1 mill per acre for areas where productivity is low and other public values are small to 1 cent per acre where special problems of multiple use are involved. As a result the cost per acre for range surveys and plans varies by ownership from about 5 mills per acre on private land to 9 mills on the national forests.

TABLE 85.—*Area and cost of range surveys and management plans, by ownership classes*

Ownership classes	Area (acres)	Cost	
		Total	Per acre
National forests	56, 800, 000	$512, 000	$0. 0090
Indian lands	28, 500, 000	210, 000	. 0074
Public domain—grazing districts, etc	149, 390, 428	666, 000	. 0045
State and county	65, 083, 932	345, 000	. 0053
Private	215, 402, 000	860, 000	. 0040
Total	515, 176, 360	2, 593, 000	. 0050

POTENTIAL CONTRIBUTION FROM THE RANGE

The range resource has contributed enormously to the development of the West, but unfortunately in making that contribution the resource itself has been damaged to a serious extent. Range lands in most ownerships have been depleted by overgrazing, improper seasonal use, and other mismanagement. Over 50 million acres, which proved to be submarginal for such use, was plowed up in an attempt to grow wheat and other dry-land crops. The aftermath of the development period thus imposes a serious task of rehabilitation and restoration if this once great resource is to be built back up to a stage of productivity equal to that which existed under virgin conditions. That this will be a slow process on ranges from which the better kinds of plants have been removed or from which much, if not all, of the top soil has been lost is recognized. On the other hand, it is probable that by using such species as crested wheatgrass in reseeding abandoned dry farm lands the production will exceed that of the original native forage.

Not only is the restoration of the ranges required for maximum sustained livestock production, but also the function of vegetation in controlling erosion and improving water flows makes such treatment even more important. Thus the range, through livestock, furnishes a good market for the crops grown on irrigated ranches and also, if properly used, safeguards the continued satisfactory supplies of water of good quality for growing these crops.

Wildlife and recreation, two other major services of the range are almost inseparable. That neither can be developed satisfactorily under the present depleted condition of most of our ranges is perfectly clear. There is little food for game and less inspiration for people to be had from denuded or tramped-out ranges and eroded slopes and valleys.

Present excessive stocking on part of the forest range interferes with production of timber and other forest products. The tender shoots of young forest growth are grazed in the spring and needles are eaten in the late fall and winter when livestock remain on the range too long and snows cover the forage.

The extent to which the other major services will require closure for range use or reductions in numbers of stock grazed is discussed in another section. With these factors in mind and with full appreciation of the lack of a thoroughly reliable factual basis, the data on grazing capacity 50 years hence in table 82 are presented. Although a present reduction of 38.5 percent appears to be necessary if the ranges are to be restored, it is probable that at some future time the land will furnish the feed for as many livestock as are now using it to excess. To reach this objective will require full application of all of the principles of good range management. Attainment will fall short to the extent that management falls short of this ideal. In the final analysis it is not so important whether the present grazing capacity is increased by 60.7 percent by 1985 or whether it is some higher or lower figure. The important feature is the restoration of our ranges for the maximum contribution of the major uses to the welfare of the people of the West and the Nation.

A Program for Watershed Protection

Any program of management for range lands must provide adequately for the conservation of the soil and other protection of the watersheds. In view of their present condition, several methods of treating these lands will be required. Limited areas will need to be closed permanently to all grazing; small critical areas may need artificial erosion control; in some instances temporary closure to all grazing will be necessary; over a considerabe area of depleted ranges, utilization of forage more conservative than normal for range forage maintenance alone will be required; but, for the most part, the need will be answered by conservative range-management practices sufficient to bring about maximum continuous production of forage. Where vegetative depletion is not excessive and the soil resource not seriously impaired, the latter practice will ordinarily build up a productive soil mantle adequately protected from erosion and capable of absorbing maximum quantities of precipitation. In managing watershed lands in this manner, however, continual critical observations must be made to ascertain any evidence of incipient erosion on areas not now eroding and the rapidity of soil stabilization on eroding areas.

RESTORATION DURING GRAZING USE USUALLY SUFFICIENT

That the vegetative cover of the range can be restored at the same time it is being used for grazing has been demonstrated on the national forests, some privately owned land, and by research. On probably 90 percent or more of the total range area the watershed values including soil building can be conserved at the same time grazing is in progress. The one dominant theme is restoration of plant cover.

Although this usually can be accomplished by inaugurating the grazing practices previously described on badly deteriorated areas in order to shorten the period of restoration, utilization of the forage may necessarily be somewhat more conservative than would be required merely to restore grazing capacity. The inherent differences in topography and soil and the nature of the depletion and erosion over the range country will require a varied program of treatment.

On some areas of high watershed value or from which an intolerable amount of silt is coming as a result of past misuse, temporary closure to grazing is desirable. Even though the condition might ultimately be corrected during use, the element of time is extremely important. The damage likely to result even with limited use, so far exceeds the small returns from grazing on such areas that common sense dictates temporary closure. Once the plant cover is restored, these areas can again be used safely for grazing if properly managed. Careful and continued observation of such land is, however, essential to determine when these measures should be applied and when grazing can be resumed. For these reasons no attempt is made to estimate the area requiring such treatment and length of time such closure should continue. Application of a comprehensive program demands, however, that this method be used wherever needed and for such periods as may be necessary.

In some instances the municipal, agricultural, or industrial dependency on the volume or quality of water yield is so great that no impairment of watershed values can be risked and withdrawal from grazing use must be complete and permanent. Watersheds supplying domestic needs of Portland, Salt Lake City, and Pocatello are illustrative of desirable withdrawals for cities of different sizes. Some steep mountain areas with loose erosive soils, such as certain disintegrated granite slopes of central Idaho and similar areas in California, and considerable areas of vegetation types highly susceptible of erosion, must be closed for protection of investments in water-storage structures. Some areas of the arid Southwest, if they are to be protected from the erosion caused by heavy summer rains, must be restricted in use to a degree that would not be economical. Complete and permanent closure, as shown in a previous section, is recommended for 11½ million acres, or only 1.6 percent of the range area, in such exceptional situations.

ARTIFICIAL EROSION CONTROL NEEDED IN SOME CASES

On some watersheds where erosion is accelerating so rapidly that natural plant growth and reproduction cannot unaided combat and gain dominance over the forces of soil removal, artificial methods of erosion control are required. These methods include artificial revegetation as already described elsewhere, of denuded areas and supplemental structural undertakings such as terrace trenching and erosion-control dams.

Terrace trenching is a system devised to break up and halt sheet and gully erosion on slopes by retarding and controlling run-off until the vegetation can again control the situation. By a series of modified terraces built on slope contours, run-off is held until it can seep into the soil. An outstanding example of its application is on

the Davis County watersheds in Utah where 1,000 acres were treated at a cost of $44 per acre. It was only necessary to apply these methods on the denuded portions of this 16,000-acre area in order to halt erosion and check floods. This type of control has only reached the field experiment stage and therefore the cost may be reduced considerably. Obviously, however, the cost of such treatment will restrict its use to key areas on the most critical watersheds.

Erosion-control dams are used largely to control run-off in newly formed small channels and arroyos (gullies), of gentle or moderate gradient, and prevent their enlargement. In this method rough dams are built at intervals along the watercourse in such a way as to block rushes of water that have tremendous erosive force. Such erosion control has been used a great deal in the Southwest, in gullied mountain meadows in California, and elsewhere; but size and numbers of dams vary so greatly that it is meaningless to attempt average cost per acre figures. Considerable work of this type in the Wenatchee River Valley in Washington cost approximately $20 per acre and similar work on the Plumas National Forest in California necessitated expenditures of $25 per acre.

"Debris dams", with catchment basins above, have proved effective for trapping debris and reducing flood damage in established channels of watersheds in the Los Angeles region. Heavy erosion and run-off may occur locally on these exceedingly steep slopes, even when closed to grazing, if hard rains fall on areas freshly denuded by fire.

Water-spreading by diversion is also used in the Southwest, and in several other localities, as a means of erosion control. By this method dams or dikes are thrown up to divert water over flats where it is absorbed by the soil mantle. Cost per acre for this type of work in the southwestern region was approximately $2.50 to $3 per acre.

Artificial control measures on range lands obviously are rarely justified because of the expense involved, and they should be undertaken only where values to be protected are high and a definite need is demonstrated. In any event structural measures are only temporary, short-lived expedients to aid in stabilizing the soil while a cover of vegetation is becoming established. Coincident with any construction of trench terraces, erosion-control dams, or debris dams, restoration of the plant cover must begin.

RESPONSIBILITY FOR WATERSHED PROTECTION

The service which flows from properly managed watershed lands has both private and public aspects. At the one extreme is the large interstate watershed, supplying water for power, irrigation, and domestic use for industries, rural communities, and urban populations often at great distances from the headwaters. At the other extreme is the local mountain rancher who secures the same service from some small creek running through his property. Thus the obligation to protect the watersheds is a joint responsibility even though the major part must of necessity be borne by the public.

Private owners of watershed lands have an obligation to protect the watershed function. The responsibility of ownership carries with it the clear restriction that its use must not seriously damage your neighbor or the public. Thus the private owner of land does

have an obligation to so handle it that watershed values are not seriously impaired. As has already been shown for most of the area those range-management practices which will perpetuate the plant cover are all that is required. This sort of treatment is in the interest of the owner even though watershed values are ignored. Viewed realistically, critical erosion and high water yield areas should pass to public ownership to avoid the risks of misuse and damage to high public values. As shown in the earlier discussion of probable future use and ownership, such a program may involve 118 million acres now in private hands.

Municipalities dependent for their water supply on comparatively small nearby watersheds can efficiently manage and should own these areas if they are not already under the supervision of other competent public agencies.

States can and should manage their range lands in such a way as to conserve watershed values. Clearly, the responsibility of ownership carries with it the obligation to protect this most valuable service. If this responsibility cannot be redeemed by the State, it should not own the land. But States cannot cross their boundaries to manage the range lands on the watersheds of a neighboring State, even though they utilize most of the water yielded. California and Arizona, for instance, cannot pretend to manage the watersheds of the Colorado River in Wyoming, Colorado, and Utah which silt up their reservoirs and yield the water that they value so highly. Oregon cannot manage the watersheds of the Owyhee River in Idaho nor can Washington specify plans for the watersheds of the Columbia River in Idaho. Where interstate dependencies become so complicated, the only solution is Federal control of important interstate watersheds.

A Program For Wildlife

That wildlife in America—animals, fish, and birds—has not received the recognition which its importance justifies is now realized. Hunting, fishing, trapping, and the recreational opportunities so closely interwoven into their enjoyment are major factors in the social and economic development of the West. Fortunately, if properly managed, the environment required by this valuable resource of range lands can be maintained without serious interference with use for other essential purposes.

"Single use" for game will be necessary on only a limited area. Even on game refuges and bird sanctuaries, watershed protection will be furnished and recreation may be allowed with some restriction. Use by domestic livestock should not, however, be allowed on some limited areas of especial importance to wildlife, such as: (1) Nesting and feeding refuges for migratory waterfowl located at key points along the paths of flight, (2) winter range for big game where there is a critical shortage of feed for this season, (3) special areas to preserve species in danger of extinction. Closure to domestic stock because of such exceptional requirements for single use, cannot be determined from information now available. Undoubtedly part of the 20.5 million acres proposed for public acquisition for wildlife, as previously discussed, will need to be closed. Approximately 2.8

million acres are already closed for wildlife on national forests. In the aggregate the area requiring closure, however, will probably not exceed 1 or 2 percent of the range land.

JURISDICTIONAL PROBLEMS

The present system of handling wildlife on Federal lands whereby the various States claim exclusive right of control of the game within their boundaries is not working out satisfactorily. Under it, the kind of management which will give the maximum sustained contribution from wildlife and adequately protect the forage resource upon which the game is dependent has not been possible. The separation of the control of game from the control of the environment in which they live presents a serious problem which justifies earnest consideration. So far the wildlife has suffered. The prompt adoption of some effective arrangement which will make possible the initiation of desirable management practices is badly needed.

In the light of established precedents the first attempt should be to strengthen greatly the basis for cooperation between the States and the Federal Government. State laws which will permit of flexibility in treatment according to the needs of special cases and under which prompt action is possible are required in most States. In those States where a really workable plan for cooperative action cannot be worked out, the handling of wildlife on Federal lands should be turned over to the Federal Government. The problem is too acute to permit of the delays in action which now result from uncertainties as to the management of this valuable resource.

Any system of control must include wildlife on private lands and be such as to assure the retention of the hunting privilege for the average American. This precludes any system of control which tends to vest ownership of game or of the hunting privilege in the hands of private landowners. Some provision should, however, be made for a reasonable return to the owner for the public benefits derived from wildlife management and to induce his interest in maintenance on his land of an environment which is favorable to wildlife restoration. Such compensation may be in the form of a permitted fixed charge for hunting on the land, a permitted fixed charge for the game taken on the land, or a public subsidy for use and management of the land for wildlife as a national resource. The most logical solution of the ownership problem on lands or streams of exceptional public value is the acquisition of such property by some suitable public agency.

REFUGES AND SANCTUARIES

The management program must include maintenance of wildlife numbers in balance with the available feed and other environmental factors. Refuges should be of a temporary rather than permanent character and under flexible regulation so as to permit prompt adjustments with changing needs. The same basic principles for the protection of the range will apply as for domestic livestock, including proper stocking, proper class of stock, proper seasonal use, and distribution. Many small refuges usually are preferable to a few large ones in effecting wider distribution of game, in securing a

more efficient utilization of the range as a whole between game and livestock, in better provision for specific needs such as for seasonal use and in providing for a less cumbersome and more flexible handling of management adjustments.

The present system of licenses and law enforcement is not meeting the requirements of wildlife management. Under it there is a lack of flexibility which prevents immediate action on problems which arise. Too often game wardens or commissions lack the legal authority to handle the game resource effectively. Ranges already overstocked with game are now handled under laws which are designed primarily to build up numbers. In most States no legal provision is made to keep game numbers down to the grazing capacity of specific problem areas. Authorization to issue special permits with or without restriction as to number or sex of the kill and to employ a scheme of selection by drawing lots or some other equally fair system for the distribution of permits is needed in most States.

It is unfortunate that in most States the selection of game officials continues to be based on political preference. Really effective game management cannot be expected until selection of the responsible personnel is made on merit, usually under a civil-service system. It is equally important that game management be recognized as a profession and that a very high percent of the game officials be selected because of technical training in that especial field, coupled with adequate field experience. Wildlife management courses are now offered by several universities and should partially meet the problem of supplying trained men. Special training, broad experience, and a feeling of security in the job are nowhere more urgent than in this field.

Another factor in maintenance of forage and of numbers (livestock as well as game) is the suitable control of predators and of rodents. Control should aim toward effecting a balance rather than to seek extermination and will require careful consideration of relationships and of local needs.

The possibilities of artificial planting of birds, fish, and animals is by no means exhausted and needs consideration. This fits in with the idea of maintaining many small refuges, of obtaining a wider wildlife distribution, and of helping to relieve areas of congestion through removal and transplanting of surplus animals. However, such planting must avoid conflicts with other essential uses. Projects should be approved only after careful, thorough study of the conditions, needs, and possible effects. For example, the planting of elk in some places has resulted in the overstocking of ranges badly needed for domestic livestock and injury to adjoining ranches and farms.

Comprehensive management plans, local, regional, and national, must be prepared. The aim should be toward restoration and maintenance of wildlife habitats and production of wildlife on a sustained yield basis. Only through the preparation of thorough, systematic plans can this attractive and valuable resource be restored and maintained at a level that will insure maximum contributions without excessive conflicts with other uses.

A Program for Recreation

The spiritual, social, and economic importance of recreation as a form of land use in the West has been shown earlier in this report. The increase in this form of use has been almost phenomenal. The number of people so using the national forests, for example, increased from slightly more than 3 million in 1917 to more than 38 million in 1934. The national expenditures for such use now exceed 1¾ billion dollars annually and both numbers and cost seem definitely to be increasing. Improvements in automotive transportation and increases in road mileage where recreational facilities predominate, as well as increase in leisure time, all lead to the conclusion that this use will continue to grow.

The open range lands furnish an essential part of the recreational opportunity of the West. Desert outings during the spring flower season; dude ranches, based on the perpetuation of the spirit of the Old West on a de luxe scale; concentrations of use by tourists in especially attractive canyons; and use in varying degree of an untold number of resorts and camp grounds are now common and will increase.

The use of the range country for recreation seldom need interfere seriously with other uses. On some small areas, where heavy recreational use might result in pollution of intensively used domestic water supplies, recreation may have to be restricted or excluded. Similarly, some wildlife nesting or breeding grounds may have to be closed to recreational use during critical periods.

Conversely, in some areas of especially high recreational value, where concentration of people is common, it may be desirable to exclude livestock at least during some periods of the year. Normally, water supply intakes for use on camp grounds and heavily used camping areas should be fenced against livestock if this is a problem. In such instances the limited value of the forage resource left unused, as compared to the high recreational values involved, will leave little basis for objection to such closure. Normally, careful planning will make possible full recreational use without restricting either livestock or game.

That recreational use is an important source of income to the range country is coming to be realized. Many ranches which formerly depended entirely on livestock for their income now supplement this with the returns from a dude ranching business. In fact, on many of these ranches the recreational venture now predominates and the livestock operation is little more than a feature to attract and entertain the guests. Thus more and more the romance of the range livestock outfit is being capitalized into a sound, flourishing industry. The development of recreational use of the range can no longer be passed aside as an insignificant feature, rather it promises to be a major factor in the social and economic life of this country. Thus, emphasis should lead away from complete closure to livestock of areas for recreational use. The total forage value of areas which must be so closed will be so small that grazing capacity of the range as a whole will not be measurably influenced.

A Program for Forest Ranges

Included in the range area is about 154 million acres of forest land. Approximately 78 million acres of this is capable of producing commercial timber. Practically all of the forest-range area is of importance in watershed protection. It is principally summer range for cattle, sheep, and wildlife. It is also extensively used for recreation.

Accordingly, management of the forest-range area presents a problem of interrelationships of considerable importance to the West and Nation. Generally, such livestock management as will insure sustained forage production and the restoration of depleted areas will also effectively safeguard timber production and other uses. In some instances, special silvicultural measures will be necessary. Overgrazing and improper seasonal use, especially winter grazing of commercial forest areas where snow remains, must be overcome where they still prevail. The practice of promiscuous burning, in an effort to improve forage, wherever it endangers commercial timber production or important watershed values, must also be overcome.

In general, climatic conditions are more favorable on forest ranges than on the drier types at lower elevations. Accordingly, forage conditions, if not too seriously depleted, can be restored rather readily under proper management and still permit use of the forage. It is in the interest of the livestock producer to assure soil and forage maintenance and such livestock management as will safeguard other uses of forest lands.

Additional Information—A Basic Need

Enough information is already available for marked progress in the program for restoration and management of range lands. To carry out the program fully and to make it serve most effectively will, however, require the accumulation of more exact information.

More facts are needed on the true relationship of the range and its use for domestic livestock, watershed protection, wildlife, recreation, and timber production. Improved management principles must be developed, additional possibilities for artificially reseeding ranges determined, and other phases of use and management developed. Economic studies should determine more exactly the social and economic relationship of the range and how it can best serve the livestock industry, communities, the State, and Nation. A comprehensive resource and economic survey to strengthen existing data is also urgent. Not only should such a survey include an inventory of the amount and quality of forage available for domestic livestock and wildlife, watershed conditions, and other resource values, but it should also provide the basis for the coordination of range use with crop production and the whole economic structure of integrated agriculture and dependent communities in the range territory. The size and importance of the required research program are fully developed in a later section.

○